in Belgium, produced about ten tons of carbonate of soda per diem in two separate sheds. Under Mr. Solvay's guidance Mr. Mond designed plans for carrying out Mr. Solvay's process on a larger scale, according to which works were erected in Winnington in 1873. These works proved capable of producing 20 tons per diem, per element of plant. They were started early in 1874, and were the first works in which carbonate of soda was manufactured from natural brine.

When in 1881 it was decided considerably to extend the works at Winnington, Mr. Mond designed plant upon a much larger scale. Some of the apparatus used was increased in size, but a great part of the plant was constructed according to Mr. Mond's own patents, and entirely different from that hitherto in use.

Each element of this plant produces 60 tons of carbonate of soda per diem, and thus effects a great saving in labour, repairs, and first cost, as compared with the older plant.

Messrs. Brunner, Mond & Co. also exhibit refined bicarbonate, made by Mond and Jarmay's process.

The bicarbonate made by the ammonia-soda process contains a certain quantity of ammonia which cannot be got rid of by washing, and makes the product unsuitable for the market. Messrs. Mond and Jarmay dissolve this bicarbonate in warm water and pass the clarified solution in a constant stream through a series of cooling tanks. In these a pure bicarbonate of soda is deposited in small crystals. These are from time to time removed, passed through a hydro-extractor, then dried and dressed as usual.

All the ammonia remains in the mother-liquor, which is used many times over, and is then treated for the recovery of the ammonia.

MESSRS. BELL BROS., LIMITED, MIDDLESBROUGH (*Group XIV. No.* 1467).

THE AMMONIA-SODA PROCESS (SCHLOESING).

The patents worked by Messrs. Bell Bros. were taken out by Sidney Pitt (communications from J. J. T. Schloesing) on May 28, 1878, and May 4, 1882, entitled, "Improvements in the Manufacture of Carbonate of Soda by the Ammonia Process," and numbered respectively 2130 and 2110.

The essential difference between Solvay's and Schloesing's processes is that in the former, ammonia and brine are treated together with carbonic acid under pressure; whilst in the latter ammonia is carbonated as *one separate step* of the entire process, and the small crystals of bicarbonate of ammonia precipitating are used in a *second step* to mix with brine in an agitating vessel, so as to yield bicarbonate of soda.

Messrs. Bell Bros., Limited, exhibit the following specimens :—

(1.) The bicarbonate of ammonia representing the first step of the process.

(2.) The bicarbonate of soda produced by mixing the ammoniacal salt with brine, and

(3.) The finished product.

Messrs. Bell Bros. have only somewhat recently started, and they are now manufacturing about 200 tons of alkali per month.

For a full account of the origin of the ammonia-soda process, see Mr. Mond's interesting paper commencing on this page.

THE EGLINTON CHEMICAL CO., LIMITED, GLASGOW (*Group XIV. No.* 1441).

The manufactures of this firm are represented by the following exhibits :—

(1.) *Chromate Leather*, tanned with bichromate of potash, etc.; produced in one-fifth the time of ordinary tanned leather, and at less than half the cost. It is said to be much more durable than ordinary leather, and thoroughly waterproof. Suitable for all purposes of the ordinary article, and particularly for use in the army and navy, for shooting, fishing, and football boots, hydraulic and pump leather, and for buffing purposes.

(2.) *Patent Bichromate of Soda*, as a substitute for bichromate of potash, containing as much chromic acid as bichromate of potash, and saleable at about £10 per ton under the price of bichromate of potash. Samples of chromate and bichromate of lime and of alumina are also exhibited.

(3.) *Silica Bricks*, made from pure flint. Practically free from iron; more refractory and less expansive under intense heat than Welsh Dinas bricks, or any other form of silica brick. Specially suited for lining steel and iron heating furnaces, arches of gas retorts, etc., etc.

(To be continued.)

Communication.

ON THE ORIGIN OF THE AMMONIA-SODA PROCESS.

BY LUDWIG MOND.

ALL writers on this subject from Brande in 1841 [*] to Lunge [†] in 1880, fix the date of this invention at the 30th of June, 1838, when Messrs. Harrison Grey Dyar and John Hemming, both chemists of London, filed the petition for their English patent. Only of recent years an attempt has been made by several French savants [‡] to put the date of the invention sixteen years later, in order to claim it as a French invention and to give the credit of it to two of their countrymen, Messrs. Schloesing and Rolland, who took out a patent relating to the subject in 1858, preceded by a patent taken out by Mr. Schloesing alone in 1854.

It would seem superfluous to contradict an error so palpable and so easily refuted by reference to documents accessible to everyone, had not this statement been made by three scientific men of the highest standing, whose name is sufficient to obtain acceptance for it by numbers who have not themselves inquired into the facts.

In justice to Messrs. Schloesing and Rolland, I must state that these gentlemen in their various publications have fully acknowledged that the process they endeavoured to improve had been invented long ago, and that the various chemical operations constituting the process had been described so exactly in a patent taken out in France by Delaunay as to leave to future inventors very little to do.

On referring to Delaunay's patent, dated 27th of May, 1839, this will be found an exact translation of the English specification of Messrs. Dyar and Hemming, of October, 1838, whence it is clear that Delaunay was simply the agent of Messrs. Dyar and Hemming. Inquiring further into this French specification we come, however, upon a remarkable and important fact which has hitherto been left unnoticed. This patent is followed on the 18th of May, 1840, by an additional patent, a facility enjoyed under the French patent law almost free of expense, which has evidently in this instance led the inventors to protect in France most important improvements found out shortly after taking out their original patent, while the high cost of a second English patent has prevented their doing the same in England.

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[*] Brande: Manual of Chemistry, 5th edition, pp. 661.

[†] Lunge: Manufacture of Sulphuric Acid and Alkali, viii. p. 1.

[‡] Frémy: Presidential Address to the French Association for the Advancement of Science, 1878. Bouley: Président de l'Académie des Sciences; *Comptes Rendus*, T.C. No. 14. Scheurer Kestner: Conférence à la Société d'Encouragement sur Nicolas Leblanc, 28 Mars, 1885.

As is well known, the original process of Messrs. Dyar and Hemming consisted in mixing a solution of common salt with solid carbonate of ammonia, separating the bicarbonate of soda formed from the residual liquor, boiling this liquor to dryness, and heating the dry product with chalk in order to recover the carbonate of ammonia employed. It is evident that this series of operations would involve so serious a loss of ammonia as to make the economical application of the process impossible, and if Messrs. Dyar and Hemming had left their process in this very incomplete form, their claim to be considered the inventors of the process now known as the Ammonia-soda Process might well be called in question. The additional French patent referred to above, however, puts the matter in an entirely different light. I give an exact translation of their specification:—

18th May, 1840. *Additional Patents for Improvements.* The operations can be reduced to the following:

Preparations of the Carbonate of Soda.

1st. To a concentrated solution of chloride of sodium is added an equivalent quantity of sesquicarbonate of ammonia in order to decompose it.

2nd. A current of carbonic-acid gas is passed through the mixture to saturate the ammonia, and to make the decomposition as perfect as possible.

3rd. After a sufficient time the saline deposit is collected on filters.

4th. The deposit is drained and washed either with water or with a concentrated solution of bicarbonate of soda.

5th. The saline deposit is submitted to pressing, or put immediately in a reverberatory furnace or in a retort to drive off the water, the excess of carbonic acid, and the ammoniacal salts which it may contain.

Extraction of the Ammonia from the Residues of the Operation.

1st. The liquid collected in the third operation contains ammoniacal salts; it is run into a distilling vessel.

2nd. To this liquid is added a sufficient quantity of lime to decompose the entire quantity of the ammoniacal salts, heat is applied and thus ammoniacal gas is obtained.

The ammonia gas can be employed in several different ways.

It can be simply dissolved in water.

It can be passed into a concentrated solution of chloride of sodium.

When the gas has been dissolved in water chloride of sodium is added in sufficient quantity relative to the alkalimetric value of the liquor, and then a current of carbonic acid gas is passed through to effect the decomposition of the chloride of sodium.

If the ammonia gas is added to the solution of chloride of sodium, one can at the same time or successively pass a current of carbonic gas through it.

The order of the preceding operations shows that the sesquicarbonate of ammonia is employed only once, and that after it has been decomposed, the ammonia it contains is continually used over.

In all cases, and whatever be the mode of proceeding, the chloride of sodium is decomposed under the influence of ammonia and carbonic acid.

In this operation the *ammonia must be considered as* an intermediate agent which takes hold of the carbonic acid to give it off again to the chloride of sodium, which it can then decompose, and produce carbonate of soda *through the intervention of the elements of water.*

The ammonia plays here a part similar to that of the binoxide of nitrogen in the preparation of sulphuric acid, and to that of the acetate of lead in the manufacture of *white lead by the process of Thénard.*

In order to make this process economical, the principal object should be the preservation of the ammonia, the employment of which ought to be continued till it is, so to say, used up.

As to the carbonic acid likewise employed in this process, it can be produced economically by the combustion of coal, or by the calcination of limestone as practised in other manufactures.

Here we have described in detail all the operations as they are this day carried out in the manufacture of the immense quantities of ammonia-soda now produced, and we may well agree with Messrs. Schloesing and Rolland that, as far as the chemistry of the ammonia-soda process is concerned, Messrs. Dyar and Hemming left very little to do to future inventors. Still there is the fact that from 1840, when the chemistry of the process was fully developed, until 1865, this remarkably simple and beautiful process found no application, although many very eminent engineers, chemists, and manufacturers spent years of their time and large sums of money in endeavouring to realise it on an industrial scale. All these attempts, including the one made by Messrs. Schloesing and Rolland between 1855 and 1858, ended in failure. If it could be shown that these gentlemen, by the apparatus they have patented, or by the experiments they have made to work the process on a large scale, had advanced the ultimate success of the process, they would, although not being the inventors of the process, deserve great credit, and no objection could be raised to the award of the diploma of honour which they have obtained at the Vienna International Exhibition. A close examination of the facts unfortunately does not show that they have in this direction done more than their predecessors and contemporaries.

The fact that bicarbonate of soda is formed by mixing carbonate of ammonia with a strong solution of salt has been known, although it was never published, long before the date of Messrs. Dyar and Hemming's patent. A. Vogel* tells us that he found this fact mentioned in his father's note-book as far back as 1822. Dr. Angus Smith has told me that his friend Mr. John Thom has shown him this reaction, performing it in the palm of his hand, several years before 1838. I owe to Mr. Watson Smith fuller particulars of Mr. Thom's early work in connection with this subject, contained in several letters from Mr. Thom himself, which are corroborated by a letter from *Mr. William Henderson*, of Glasgow. These letters leave no doubt that Mr. Thom actually manufactured soda by the action of carbonate of ammonia upon salt in 1836 at the works of Messrs. Turnbull & Ramsay at Camlachie, where he was employed as chemist. Mr. Thom mixed the two salts intimately with a small quantity of water, and put the resulting *magma* in bags into a press in order to separate the liquid from the bicarbonate formed. The bicarbonate was used for making soda-crystals, of which about two hundred-weights per day were produced. The liquid was evaporated, mixed with chalk, and heated in iron retorts to recover carbonate of ammonia. After working the process for about a year, Mr. Thom left the works at Camlachie, and did not follow up the subject any further. Here we have in all probability the first attempt to turn the reaction between salt and carbonate of ammonia to practical use. But the operations were still so crude, the separation of the bicarbonate of soda from the chloride of ammonium so unsatisfactory, the reaction between salt and sesquicarbonate of ammonia without the aid of carbonic acid so imperfect, and the process used for recovering the carbonate of ammonia so impracticable, that how ever highly we may think of Mr. Thom's merits as the discoverer of the principal reaction, and as the first who attempted to manufacture soda by its aid, yet he cannot be considered to have invented a chemical process industrially applicable for this purpose. The merit of having invented the series of reactions now forming the ammonia-soda process remains thus undiminished with Messrs. Dyar and Hemming, who, as far as can be inferred from Mr. Thom's letters, have worked quite independently of him and without knowledge of what he had been doing.

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* *Chem. Centralblatt*, 1871, p. 98.

According to information, for which I am indebted to Mr. Richard Muspratt, Messrs. Dyar and Hemming built a small works to demonstrate their process in Whitechapel very shortly after taking out their patent. These works were regularly visited by Dr. Sheridan Muspratt and Mr. James Young of paraffin celebrity, then assistant to Professor Graham in London, in order to study the process. Shortly afterwards, probably in 1840, Mr. James Muspratt engaged Mr. Young to erect plant for the process on a considerable scale, at his large chemical works at Newton. This plant was worked under Mr. Young's direction for about two years, when the process was given up because it was found more expensive than the Le Blanc process, principally on account of the heavy loss of ammonia. Mr. Carrol, at the time foreman of the works at Newton, has told me that about £8000 were spent in this experiment.

It is well known that various other attempts to work the process were made about this time on the Continent, amongst others, by Kunheim in Berlin, and Seybel in Vienna. A few years later a small plant was erected near Leeds by Mr. Bowker, and kept at work for several years, the product being regularly sold in the district, but this also was subsequently abandoned. The first attempt to construct a more perfect plant for carrying out the process was made by Mr. William Gossage (patent of 21st February, 1854). In the same year, and following each other in close succession, patents were taken out by Turck (26th May), Schloesing (21st June), Henry Deacon (through his agent, Henry Johnson, 8th July). I am informed by Mr. Holbrook Gaskell, who entered into partnership with Mr. Deacon in 1854, that Mr. Deacon leased land for the purpose of erecting ammonia-soda works in 1853, and that in the following year he was already engaged in the manufacture of ammonia-soda, which he carried on for about two years at the rate of several tons per day. After a sum of from five to six thousand pounds had been expended upon it, the firm decided to abandon the ammonia-soda process, and commenced the erection of the large Le Blanc Soda Works, which have since become so well known, and which have proved such a fruitful field for the display of Mr. Deacon's great powers as a manufacturer and as an inventor.

Judging from Mr. Deacon's patent, and from what he has told me himself many years ago, the plant which he used for making ammonia-soda was very similar to that described by Messrs. Schloesing and Rolland in their patent of 1858, except that Mr. Deacon went a considerable step further than these gentlemen by using carbonic acid under pressure. He used horizontal cylinders with agitators for absorbing the carbonic acid, and a still of the Coffey type for recovering the ammonia.

Messrs. Schloesing and Rolland commenced in 1855 to erect works at Puteaux, near Paris, which were kept going for two years, and during this time produced 316 tons of soda—86 tons during the first 14 months, and 230 tons during the last ten. At the end of the two years the experiment was given up, like all the preceding ones had been, although the soda manufactured was sold at a price varying from 65 to 75 francs per 100 kilogrammes, equal to £26 to £30 per ton, or about five times its present value. Messrs. Schloesing and Rolland assert, in a very lengthy paper published in 1868 (*Ann. de Chimie und Physique*, T. xiv.), and this assertion has been repeated by various writers, that their want of success has been due, not to the insufficiency of their apparatus, but solely to the high tax levied on salt at the time in France. They state that they had to use 180 kilogrammes of salt per 100 kilogrammes of soda, where the Le Blanc makers used 150 kilogrammes, and that the tax they had to pay on this extra quantity of salt made competition impossible. This duty amounted to 10 francs per 100 kilogrammes of salt. Messrs. Schloesing and Rolland would thus have to pay 3 francs per 100 kilogrammes of soda more than their competitors, an amount very much below the difference in cost of production between the two processes at the present time. The total tax they had to pay on salt would have amounted to 18 francs per 100 kilogrammes of soda manufactured. The selling price of soda at the time being 65 to 70 francs per 100 kilogrammes, Messrs. Schloesing and Rolland ought to have realised enormous profits in spite of the tax if they had at all understood the manufacture. The selling price to-day is below 18 francs per 100 kilogrammes, and this leaves a very handsome profit. Moreover, it would have been easy to reduce the quantity of salt consumed per ton of soda in the ammonia-soda process to a less quantity than is used in the Le Blanc process, by recovering the undecomposed salt from the residual liquor of the distillation. We can, therefore, not accept the assertion that but for the salt duties Messrs. Schloesing and Rolland could have manufactured at a profit; their own figures prove plainly that their experiment was no more successful than their predecessors; that it was not carried out on any larger scale, nor persevered with for a longer period of time.

After 1858 no further serious attempts were made to overcome the engineering difficulties of the ammonia-soda process, until Mr. Ernest Solvay undertook this task in 1863. It is now a matter of history how completely Mr. Solvay succeeded, after five years of incessant work, under trying circumstances, in inventing and working out new apparatus for carrying out on a large scale all the various operations of Messrs. Dyar and Hemming's beautiful but hitherto barren invention; how quickly the ammonia-soda manufacture has developed in his hands, and what enormous proportions it has attained in a comparatively short time. While recognising Messrs. Dyar and Hemming as the inventors of the chemical operations which constitute the ammonia-soda process, we have to give to Mr. Solvay the honour of being the inventor of the apparatus, which alone has made this process of value to the public, and of having thus become the founder of the ammonia-soda industry.

Journal and Patent Literature.

I.—GENERAL PLANT, APPARATUS, AND MACHINERY.

Improved Process and Apparatus for Purifying Water used in Steam Boilers. D. Clerk, Glasgow. Eng. Pat. 10,815, July 31, 1884.

The water of the boiler is made to circulate, by means of pipes and a steam pump, through a filter, and is redelivered at the upper part free from the solid matters which separate from it during evaporation. The feed water is also caused to pass through the same filter.

—C. C. H.